

## A. General

On a diesel engine, combustion is effected by self-ignition of the fuel sprayed into the highly compressed and thereby highly heated combustion air.

In a cold engine, the self-ignition temperature is not attained by compression alone. A preglow system is therefore required, which serves the purpose of increasing the temperature of the compressed air to facilitate starting of the cold engine by the inflammation of fuel particles on filament of glow plug.

The duration of preglowing (preheating) depends on temperature of engine and on ambient temperature.

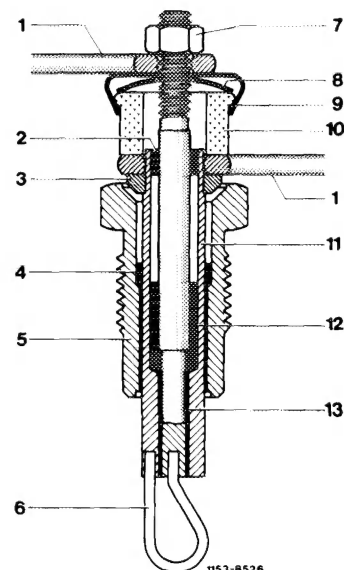
## B. Glow plug design

### a) Filament-type glow plugs

The filament-type glow plugs are essentially comprising the plug body (5) with threads M 18 x 1.5, one center electrode with filament wire and the outer electrode. The current is carried by conductor (1) or a connecting cable, depending on location of plug, to center electrode (13) or to ring element (3) of outer electrode (11). The center electrode (13) and the outer electrode (11) are connected to each other by means of the glow filament (6). The two electrodes are insulated in relation to each other by the insulating compound (12) and in relation to the plug body (5) by the insulation compound (4).

In addition, a plastic insulator (2) is installed at upper end of glow plug between outer and center electrode. The connection insulator (10) insulates the two current connections. The domed washer (8) installed in insulator serves as a lock for nut (7).

- |                                     |   |
|-------------------------------------|---|
| 1 Conductor                         | 8 Domed washer                            |
| 2 Plastic insulator                 | 9 Sheet-metal cap on connection insulator |
| 3 Ring element (on outer electrode) | 10 Connection insulator                   |
| 4 Insulation compound               | 11 Outer electrode                        |
| 5 Plug body                         | 12 Insulating compound                    |
| 6 Glow filament                     | 13 Center electrode                       |
| 7 Nut                               |   |



The life of a glow plug depends to a considerable extent on the condition of the injection nozzle and the combustion sequence. Injection pressures which are too low, binding nozzle needles, coked and dripping nozzles as well as a too early begin of injection may result in early breaking of filament. In addition, oil carbon bridges may lead to a ground connection and subsequent burning of filament.

If a glow plug is burnt out, it is absolutely necessary to check the glow plug which comes next in circuit, since a short-circuit between the threaded stem (1) and the outer pole (2) or the outer pole and cylinder head by metallic foreign particles or soot is possible. In addition, any residue in threaded bore of cylinder head must be removed.

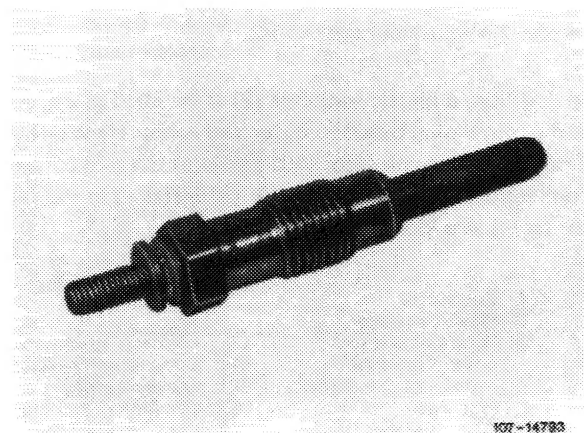
The temperature of the glow filament during pre-heating may amount to approx. 900–1000 °C. The combustion temperature of the engine at operating temperature amounts to approx. 800 °C. Temperatures above 900 °C during continuous operation will shorten the life of glow plugs. The glow plugs have an input of approx. 60 amps at a voltage drop of approx. 0.9 volt per glow plug. They are connected in series with resistance conductors.

#### **b) Quick-start pencil element glow plugs**

The quick-start pencil element glow plugs are essentially comprising a housing with M 12 x 1.25 threads and a heater rod pressed into housing.

The single-pole connecting pin is screwed to housing by means of a round brass nut which cannot be released.

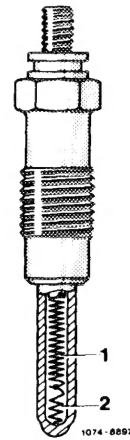
The pencil element glow plugs are designed for a voltage of 11 volts and are operated in parallel.



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The heater element comprises a heating and control coil connected in series.

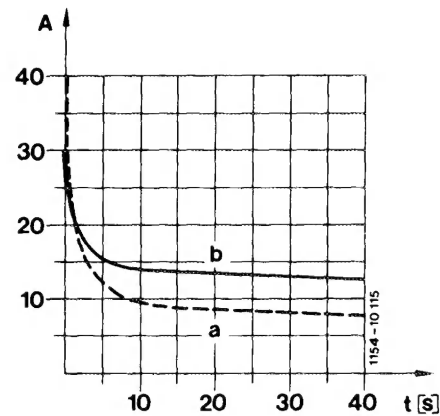
- 1 Control coil
- 2 Heater coil



When the glow system is switched on, a current of approx. 30 amps will flow per glow plug.

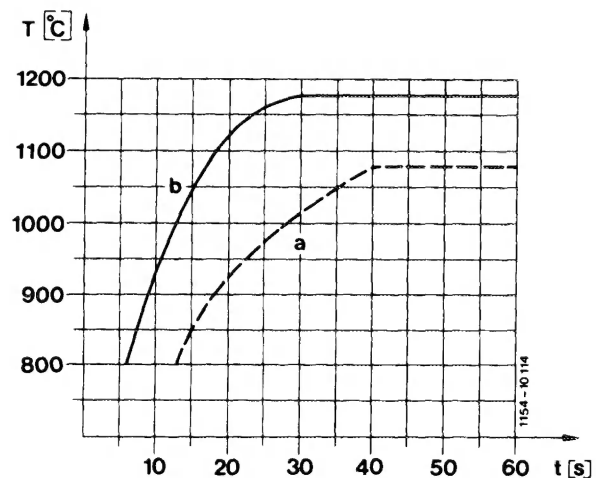
The heater coil heats the glow plug very quickly.

The control coil increases its resistance with increasing temperature and restricts the current to approx. 14 amps. This will protect the glow plug against overload.



b Current curve of quick-start pencil element glow plug

After a glow period of 9 seconds, a pencil element temperature of 900 °C/1652 °F is attained, after 30 seconds the max. temperature of 1180 °C/2147 °F.



b Temperature curve of quick-start pencil element glow plug

## C. Preglow system with glow plug resistance control engine 615, 616 in model 115.1

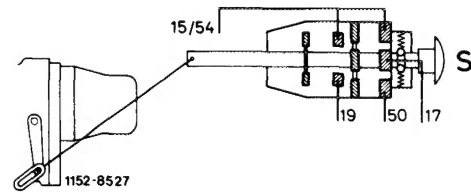
### Operation

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The mechanical-electrical preglow start and stop switch is a pull-push switch with four switch positions: stop position, drive position, preglow position and start position. In addition, the preglow start and stop switch is provided with a lock so that the key can be pulled off only in stop position.

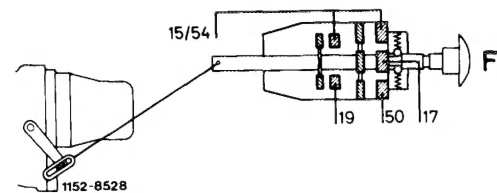
#### Stop position

In stop position the knob of the pull-push switch is completely pushed in and the adjusting lever on injection pump is moved into full forward position by means of the Bowden wire. In this position of the adjusting lever the control rod is in "stop" position, the pistons of the elements are at zero delivery, the engine receives no more fuel and will stop. In this position, the terminals 19, 50 and 17 are de-energized. The key on steering lock can be pulled off.



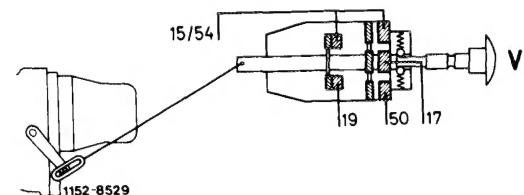
#### Drive position

In drive position, the Bowden wire with the oblong eye in relation to adjusting lever is located in such a manner that the eye is not resting against bolt of adjusting lever so that the adjusting lever is not actuated. When pulled out of stop position, the knob engages in the next following detent for the drive position. Terminals 19, 50 and 17 are de-energized. The key on steering lock cannot be pulled out.



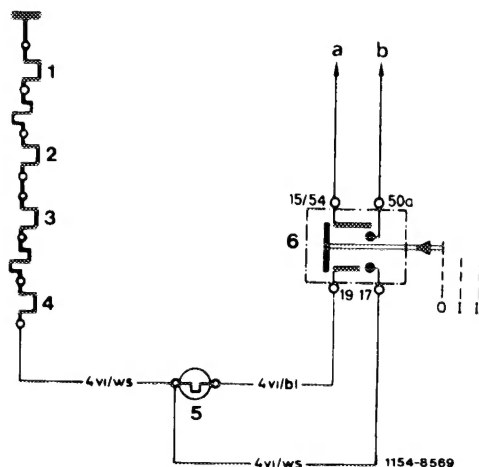
#### Preglow position

After pulling knob out of drive position into preglow position, a small resistance will be felt. In this position, the switch must be held in place until the preglowing is completed.



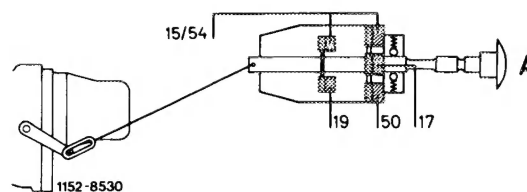
In this position, terminal 19 is energized, glow plugs (1–4) will begin to glow via glow plug resistance control (5). Terminals 50 and 17 are de-energized.

- 1–4 Glow plugs and resistors
- 5 Glow plug resistance control
- 6 Preglow starter switch
- a To steering lock
- b To starter



### Start position

When preglowing is completed, the knob is pulled completely up to stop after overcoming the minor resistance and is held in place until the engine fires.



In start position, the bolt of the adjusting lever rests against eye and is pulling the adjusting lever completely to the rear.

This will push the control rod beyond the full load stop and the injection pump will inject the starting fuel.

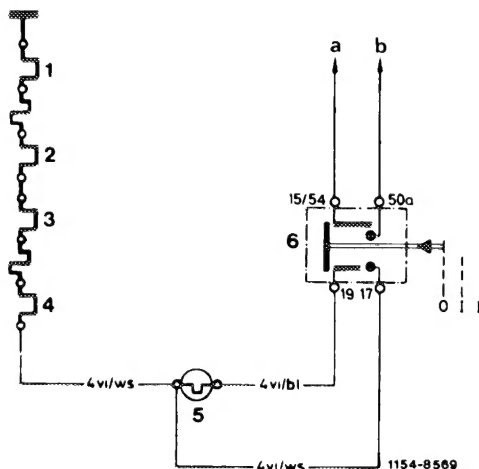
In starting position, terminals 50 and 17 are energized. The starter begins to function via terminal 50.

The glow plugs remain energized also in starting position via terminal 17.

To prevent the voltage drop on glow plugs from becoming too high during starting, the glow plug resistance control is bypassed.

When the knob of the pull-push switch is released, the switch will automatically return into driving position under the influence of springs.

- 1–4 Glow plugs and resistors
- 5 Glow plug resistance control
- 6 Preglow starter switch
- a To steering lock
- b To starter



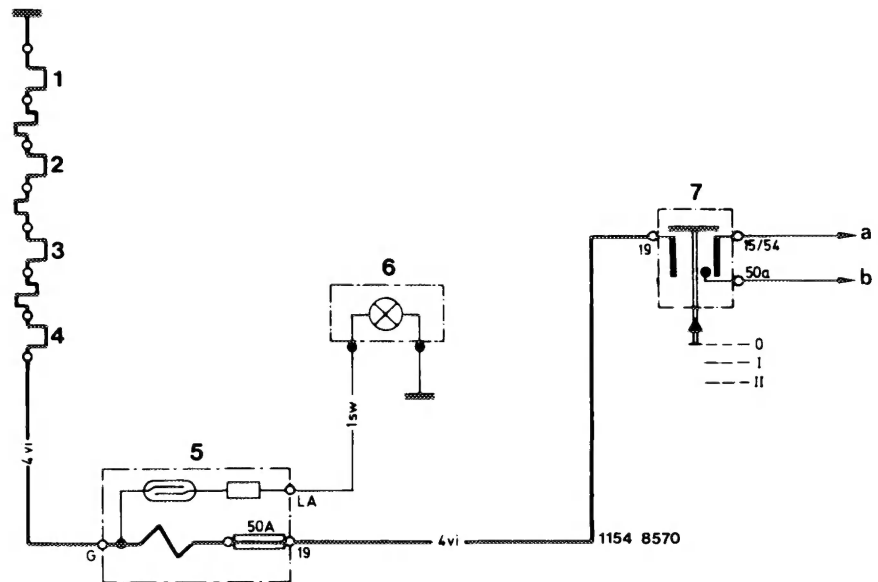
## D. Preglow system with preglow indicator lamp engine 615, 616 in model 123.1

### Operation

The preglow system is switched on by pulling preglow starter switch into position I. The preglow indicator lamp lights up as long as preglowing continues.

The glow plugs are connected in series and protected by a 50 amps fuse.

- 1-4 Glow plugs and resistance bars
- 5 Fuse and reed contact
- 6 Preglow indicator lamp
- 7 Preglow starter switch
- a To steering lock
- b To starter



The preglowing current of approx. 50–60 amps is determined by the firm resistances of the glow plugs, as well as by the resistance conductors.

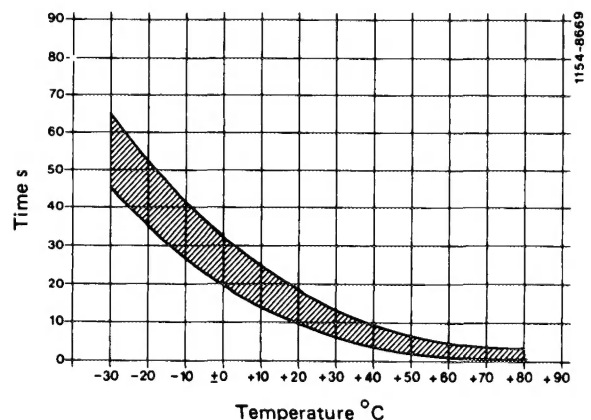
Too high a preglowing current is the result of a ground connection or short-circuit in preglow system, e. g. a defective glow plug.

Too low a preglowing current is the result of transition resistance caused e. g. by a loose glow plug connection or by an insufficiently charged battery.

The preglowing time depends on the ambient temperature and the coolant temperature and can be set at will. For the cold engine, the following preglowing periods are reference values:

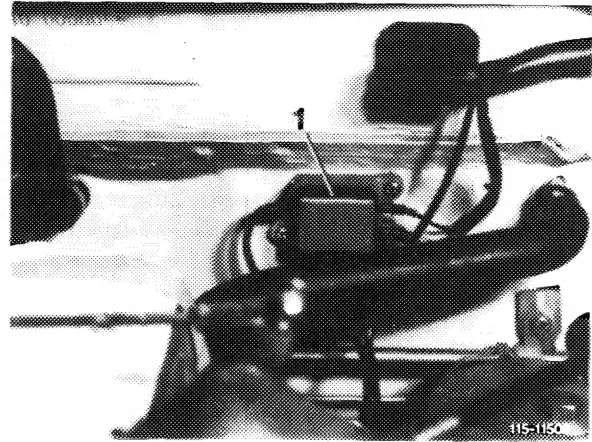
Ambient temperature +20 °C approx. 10 seconds  
 Ambient temperature 0 °C approx. 20 seconds  
 Ambient temperature -5 °C approx. 30 seconds

At lower temperatures pertinently longer up to max 1 minute.



Glow period at 52 amps

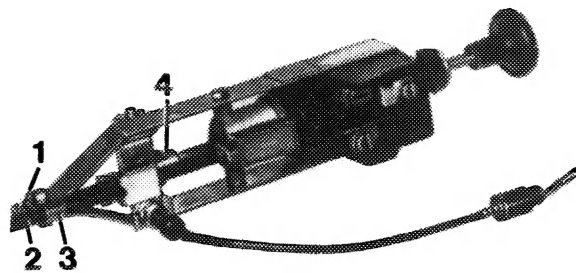
The preglow indicator lamp lights up as long as the preglow system is actuated. It is contacted with plus by means of the reed contact located in parallel with fuse. The reed contact is closed if the available glow current is adequate. Minus of indicator lamp is continuously connected to ground.



The engine is stopped by pushing preglow starter switch down.

Mechanical speed increase is effected by turning knob on preglow starter switch.

Turning counterclockwise = higher speed  
Turning clockwise = lower speed



- |                                       |         |
|---------------------------------------|---------|
| 1 Start and stop control              | 3 Clamp |
| 2 Bowden wire for idle speed adjuster | 4 Fuse  |

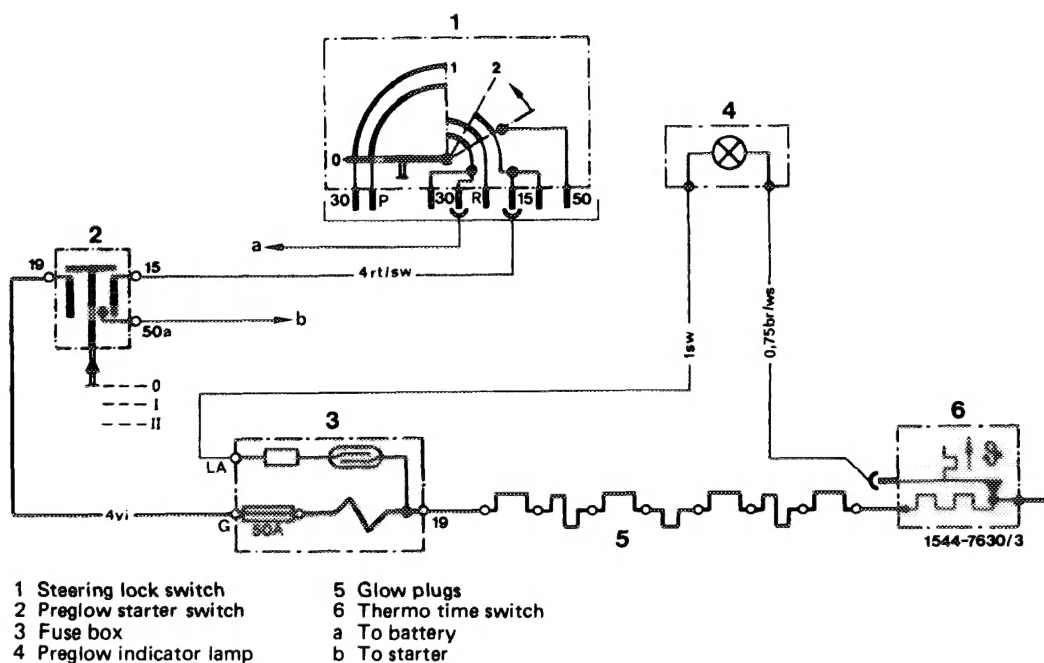
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## E. Preglow system with ready-for-starting lamp engine 615, 616 in model 123.1

### Operation

The preglow system is switched on by pulling preglow starter switch into position I. The ready-for-starting condition of engine is indicated by an indicator lamp in instrument cluster. The glow plugs are connected in series and protected by a 50 amps fuse.

The preglow current of approx. 55 amps is determined by the firm resistors of the glow plugs, as well as the resistance conductors.

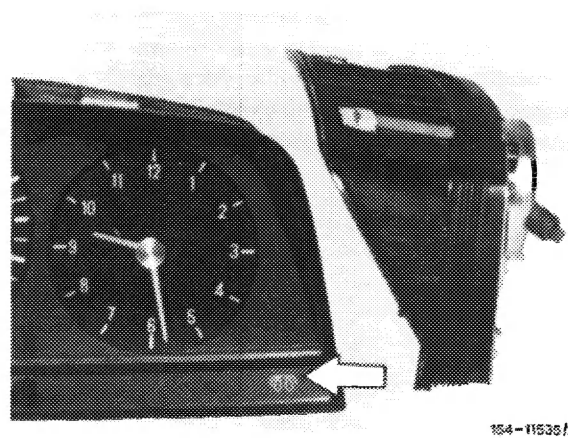


The reason for an excessively high glow current is a ground connection or short-circuit in the preglow system, e. g. a defective glow plug.

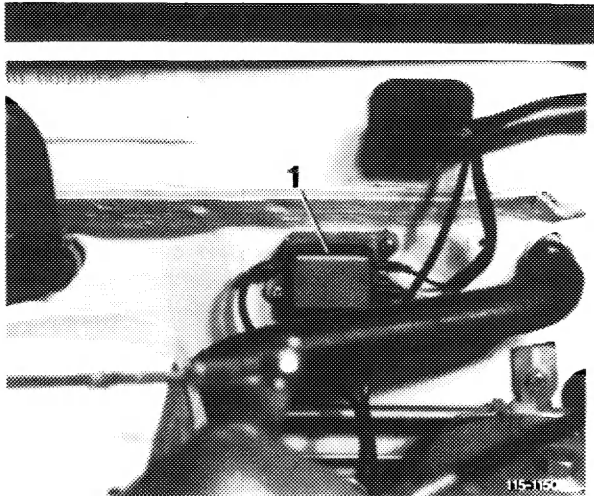
The reason for a too low glow current is a transfer resistance, e. g. a loose plug connection or an insufficiently charged battery.



The preglowing time is indicated in dependence of the ambient temperature and the engine temperature by a preglow indicator lamp in instrument cluster.



In preglow position and in starting position (I and II) of preglow starter switch the preglow indicator lamp is contacted with plus by means of a reed contact connected in parallel with fuse and closed if adequate glow current is available. The preglow indicator lamp is connected to minus by way of the rest contact in thermo time switch. At the end of the optimal preglow period the contact in thermo time switch opens. The preglow indicator lamp is extinguished and thereby shows that the engine is ready for starting.



#### F. Preglow system with key start system engine 617 in model 115.1

##### Operation

When the steering lock starter switch is actuated, in position "2" (preglowing start), the preglow system is switched on by the preglow time relay. The extinguished preglow indicator lamp in instrument cluster shows that the engine is ready for starting.

The glow plugs are started in series.

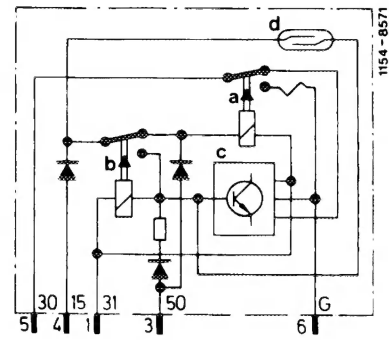
The preglow current of approx. 50–55 amps is determined by the firm resistors of the glow plugs and the resistance conductors.

Too high a preglowing current is the result of a ground connection or short-circuit in preglow system, e. g. a defective glow plug.

Too low a preglowing current is the result of transition resistance caused e. g. by a loose glow plug connection or by an insufficiently charged battery.

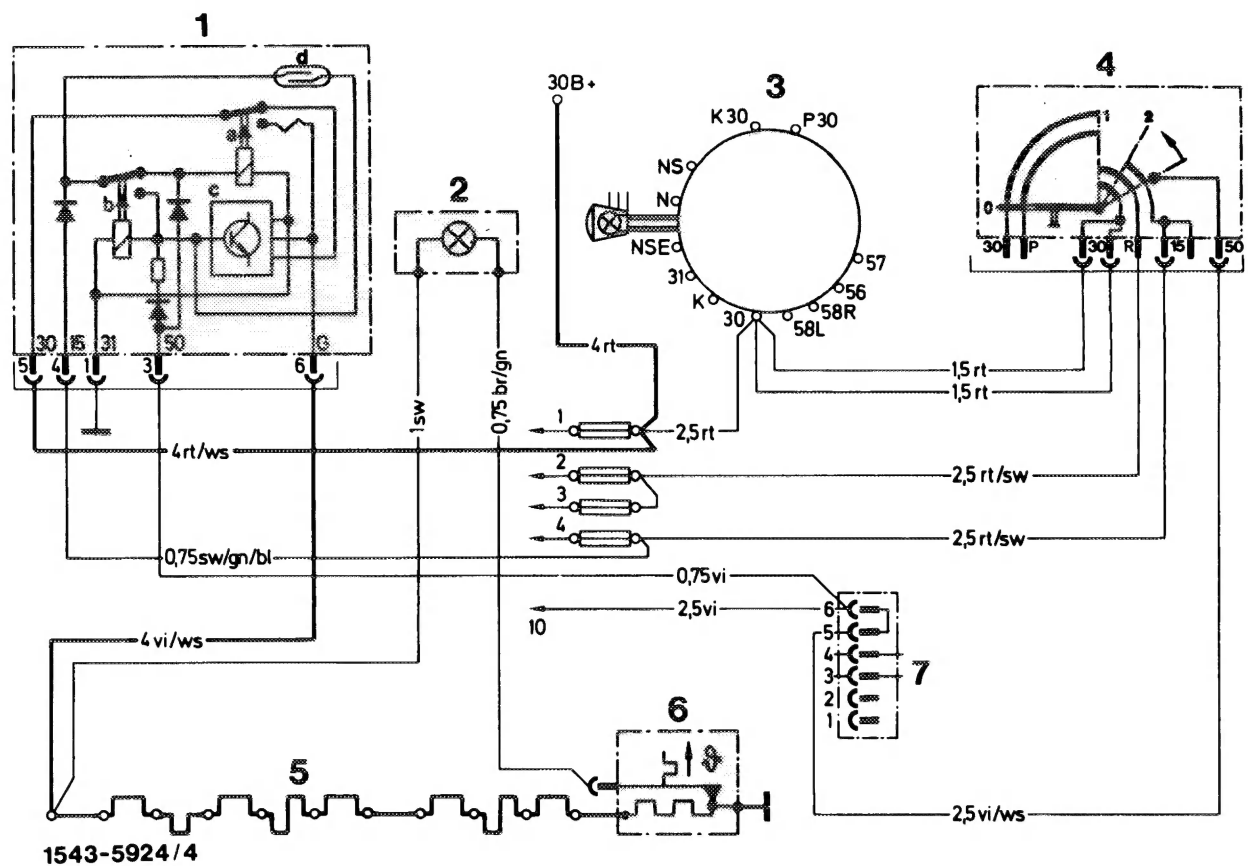
The preglow time relay is attached to pedal assembly behind instrument cluster.

The preglow time relay has an integrated power relay (a) for preglow current, a control relay (b) for switching off power relay, an electronic component (c) for the safety circuit and a reed contact (d) as overload protection.



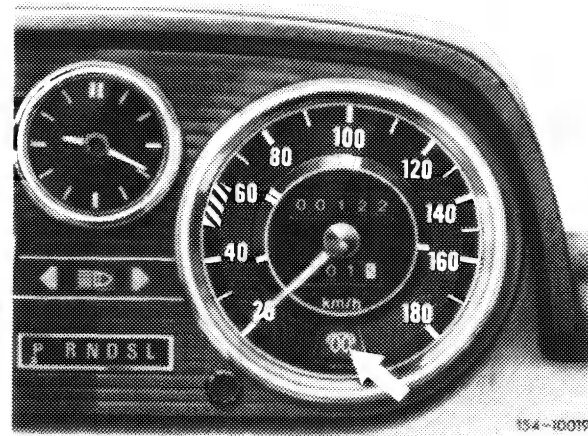
In key position "2" terminal 4 of preglow time relay (1) is contacted via terminal 15 of steering lock starter switch (4) and the winding of power relay (a) via the rest contact of control relay (b).

The contacts of the power relay are closing the preglow circuit. From B+ the preglow current flows via terminals 5 and 6 of preglow time relay (1) across the glow plugs and the thermo time switch (6) to ground. The preglow system is in operation.



- |                                 |   |
|---------------------------------|---|
| 1 Preglow relay                 | 5 Glow plugs with resistance conductors |
| 2 Preglow indicator lamp        | 6 Thermo-time switch                    |
| 3 Rotary light switch           | 7 Plug connection                       |
| 4 Steering lock starting switch |   |

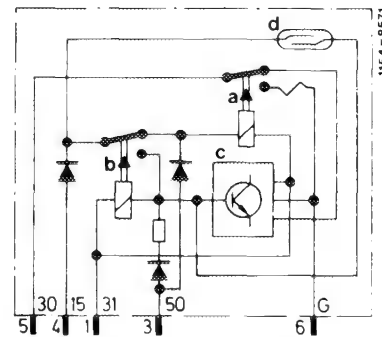
The preglow time is indicated by the preglow indicator lamp.



In dependence of the coolant temperature and the preglow current flowing across the thermo time switch, the preglow indicator lamp is contacted with minus by the closed contact in thermo time switch. In parallel with the glow plugs, the control lamp is connected to plus by a line connected to the glow plug of the 5th cylinder. When the optimal preglow time is obtained, the contact in thermo time switch will interrupt minus and the preglow indicator lamp is extinguished. The engine is now ready for starting.

In starting position the preglow time relay is contacted by terminal 50 of the steering lock starter switch via terminal 3. Control relay (b) is energized. The contacts are closing (interrupting the rest position) and remain closed via terminal 4 in a self-holding circuit.

The power relay (a) is not switching off, since during the starting operation the power relay is directly contacted via terminal 3. The preglow system remains switched on (refer to wiring diagram).



At end of starting operation the key moves back into position "2" (preglowing, drive).

The power relay switches off, since there is no voltage neither via terminal 3, nor via the interrupted rest contact of the control relay which remains switched on via terminal 4.

The preglow system is now in disconnected condition.

**Attention!**

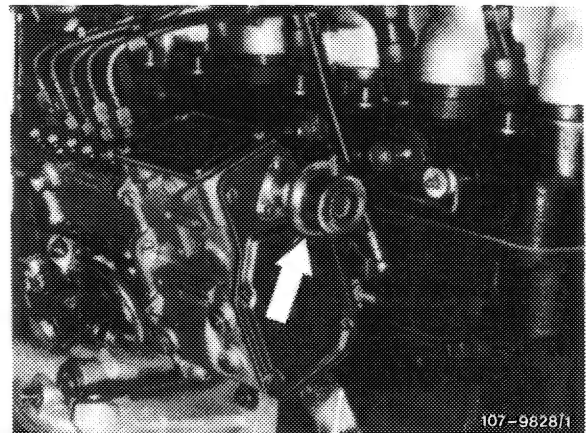
If the engine is not started when the preglow indicator lamp is extinguished, the preglow system remains switched on up to  $90 + 20$  seconds of preglow time.

When working in engine compartment, note that in such a case the resistance conductors are red hot.

After  $90 + 20$  seconds the safety relay is energized for a short moment by control relay (b). The control relay attracts and remains switched on under self-holding condition. The rest contact is interrupted and disconnects the voltage at power relay (a). As a result, the contacts of the power relay will interrupt the preglow current. The preglow system is now inoperative.

The engine is shut off by turning key to position "1" or "0".

The steering lock has an attached valve which is actuated by way of a cam when the key is turned. A vacuum box on injection pump is provided with a vacuum and the regulating rod of the injection pump is pulled to "stop".



## G. Preglow system with key start system engine 615, 616, 617 in model 123.1

### Operation

When the steering lock starter switch is actuated in position "2" (preglowing, start) the preglow system is switched on by the preglow time relay. The extinguished preglow indicator lamp in instrument cluster shows that the engine is ready for starting. The glow plugs are started in series and protected with a 50 amps fuse.

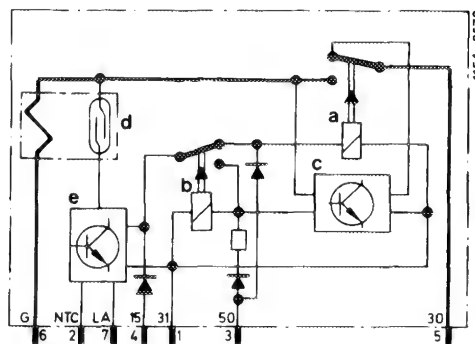
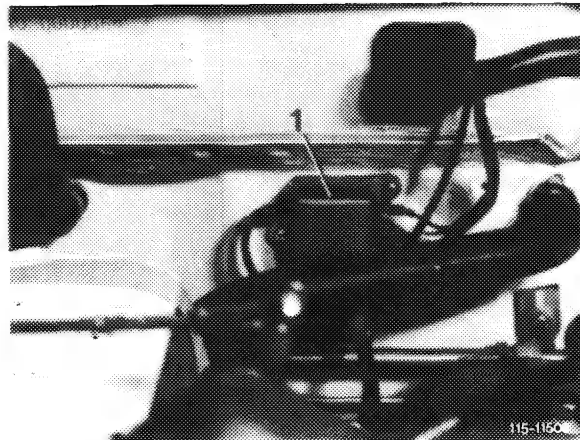
The preglow current of approx. 50–55 amps is determined by the firm resistors of the glow plugs and the resistance conductors.

Too high a preglowing current is the result of a ground connection or short-circuit in preglow system, e. g. a defective glow plug.

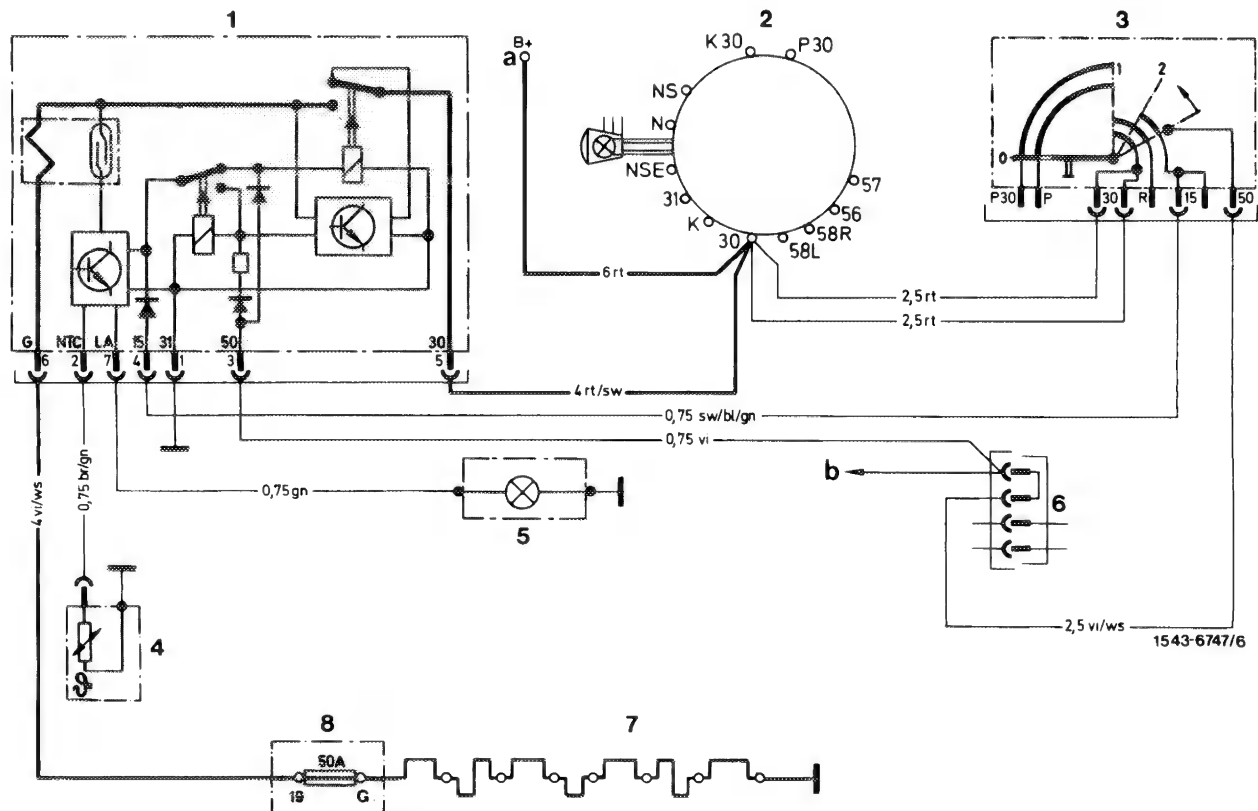
Too low a preglowing current is the result of transition resistance caused e. g. by a loose glow plug connection or by an insufficiently charged battery.

The preglow time relay is attached to instrument cluster on pedal assembly.

The preglow time relay has an integrated power relay (a) for preglow current, a control relay (b) for switching off power relay, an electronic component (c) for the safety circuit and an electronic component (d) with a primary reed contact for the preglow indicator lamp.

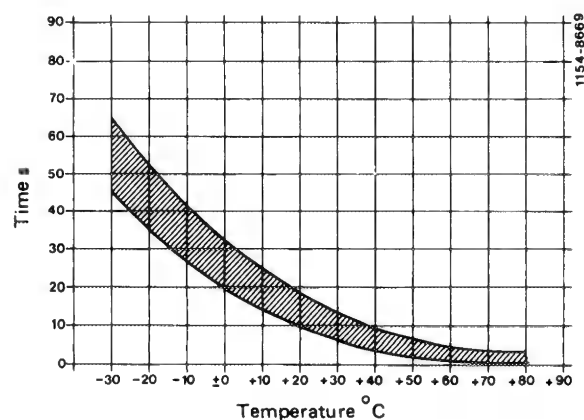


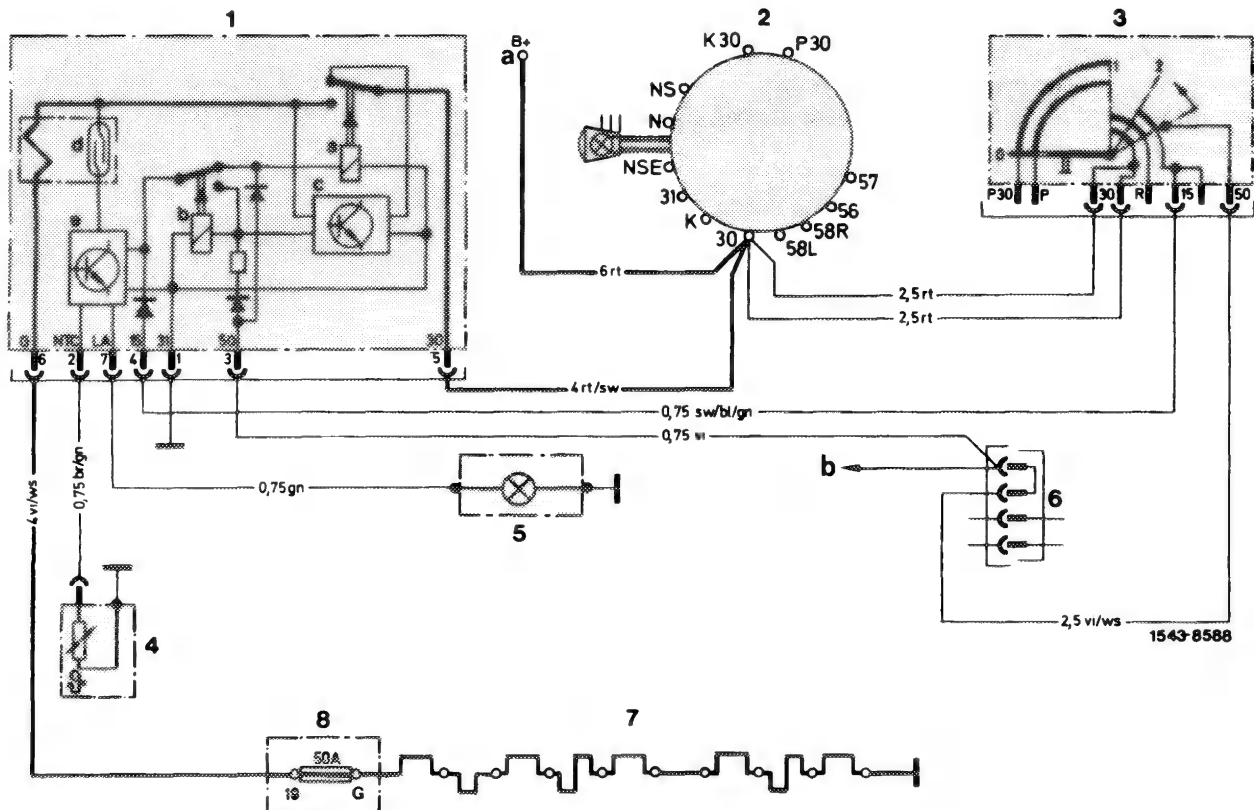
The contacts of the power relay are closing the preglow circuit. From B+ the preglow current flows across terminal 5 and 6 of preglow time relay (1) via fuse (8) and the glow plugs to ground.



1 Preglow time relay	6 Plug connection
2 Rotary light switch	7 Glow plugs with resistance conductors
3 Steering lock starting switch	8 Fuse box
4 Temperature sensor	b To starter terminal 50
5 Preglow indicator	

The optimal preglow period is indicated when the preglow indicator lamp goes out.



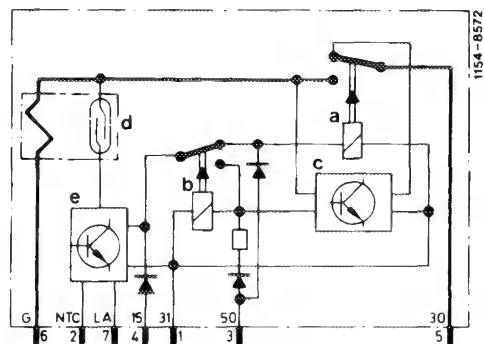


Wiring diagram engine 617

- |                                 |                          |   |
|---------------------------------|--------------------------|---|
| 1 Preglow time relay            | 4 Temperature sensor     | 7 Glow plugs with resistance conductors |
| 2 Rotary light switch           | 5 Preglow indicator lamp | 8 Fuse box                              |
| 3 Steering lock starting switch | 6 Plug connection        | b To starter terminal 50                |

In starting position the preglow time relay is contacted by terminal 50 of the steering lock starter switch via terminal 3. Control relay (b) is energized. The contacts are closing (interrupting the rest position) and remain closed via terminal 4 in a self-holding circuit.

The power relay (a) is not switching off, since during the starting operation the power relay is directly contacted via terminal 3. The preglow system remains switched on.



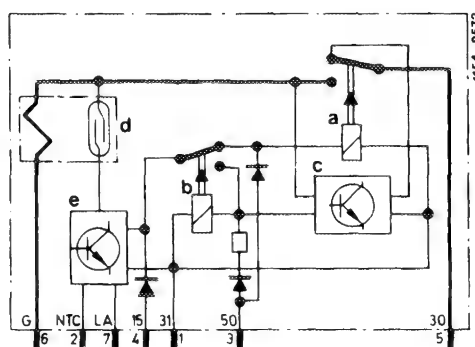
At end of starting operation the key moves back into position "2" (preglowing, drive). The power relay switches off, since there is no voltage neither via terminal 3, nor via the interrupted rest contact of the control relay (b) which remains switched on via terminal 4. The preglow system is now in disconnected condition.

**Attention!**

If the engine is not started when the preglow indicator lamp is extinguished, the preglow system remains switched on up to  $90 + 20$  seconds of preglow time.

When working in engine compartment, note that in such a case the resistance conductors are red hot.

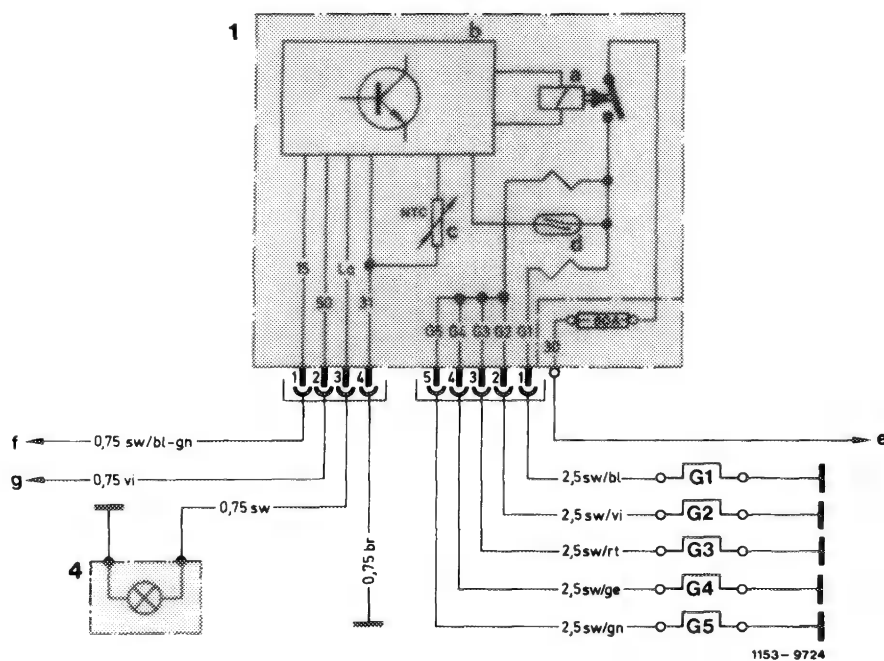
After  $90 + 20$  seconds the safety relay is energized for a short moment by control relay (b). The control relay attracts and remains switched on under self-holding condition. The rest contact is interrupted and disconnects the voltage at power relay (a). As a result, the contacts of the power relay will interrupt the preglow current. The preglow system is now inoperative.





## General

### Wiring diagram



- 1 Preglow time relay
  - a Power relay
  - b Electronic unit
  - c Temperature sensor (NTC resistor)
  - d Reed relay
  - e To starter terminal 30
  - f To fuse box terminal 15
  - g To plug connection starter lockout backup lamp switch terminal 50
- 4 Preglow indicator lamp
- G 1 – G 5 Pencil element glow plugs

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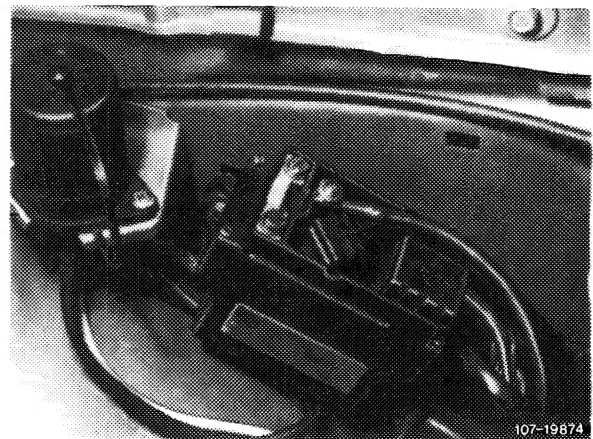
### **Quick-start pencil element glow plugs**

The quickstart pencil element glow plugs are designed for a voltage of 11 volts and are operated in parallel.

### **Preglow time relay**

The preglow time relay is located in engine compartment at the left on wheelhouse.

After removing protective cap, the electric connections, as well as the 80-amp fuse are accessible.



The former temperature sensor in coolant circuit is no longer installed. Instead, the relay temperature or relay-ambient temperature is obtained by means of an NTC resistor in preglow time relay.

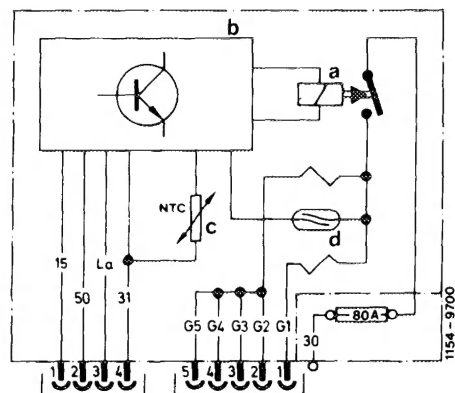
### **Functions of preglow time relay**

The preglow time relay comprises the following functions:

- Switching of glow current
- Ready-for-start indicator
- Safety shutoff
- Fault indicator

## Switching of glow current

By actuation of key in position "2" (preglow, driving), the preglow time relay (voltage at terminal 15) is engaged. The power relay (a) closes the circuit from terminal 30 (positive) via fuse to pencil element glow plugs G1 — G5.



If the key is turned to position "3" (start), the power relay (a) remains attracted, activated by terminal 50. The glow period continues until the key is turned back to position "2".

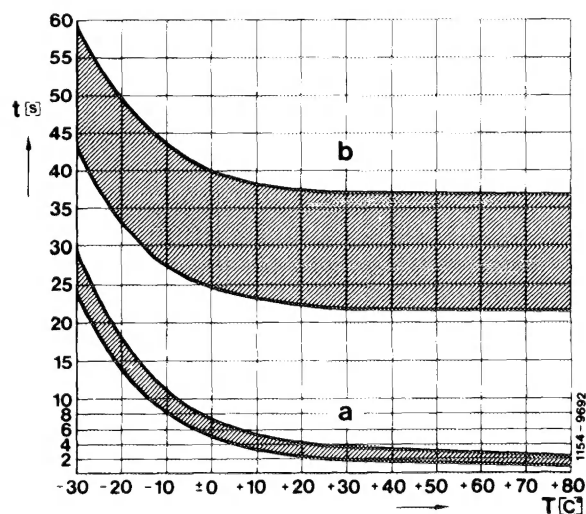
## Ready-for-start indicator

A temperature sensor installed in preglow time relay obtains the glow period.

When the glow system is switched on, the preglow indicator lamp in instrument cluster will light up.

If the required glow period, in dependence of the ambient temperature of the preglow time relay, is attained, the preglow indicator lamp goes out and thereby indicates the ready-for-starting condition.

a Preglow period

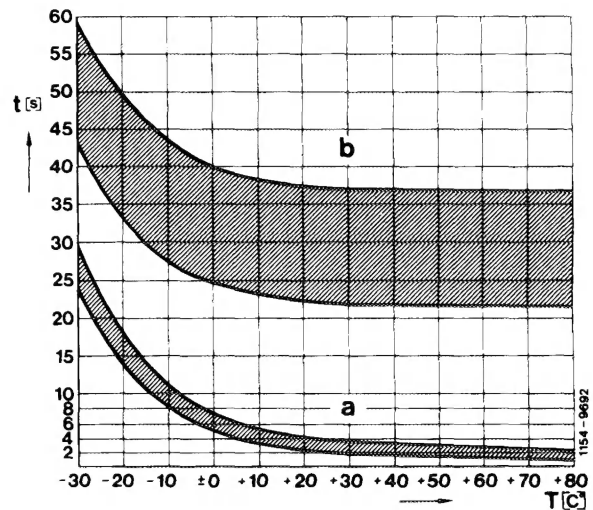


## Safety shutoff

If there is no start within 20–35 seconds following indication of ready-for-starting condition, the glow current is interrupted by the safety shutoff. If another start follows, the glow system is again switched on for the duration of the starting period.

The safety shutoff is no longer a fixed condition. It is determined by the time up to ready-for-starting condition (preglow indicator lamp goes out) plus 20 to 35 seconds.

a Preglow period  
b Safety shutoff



## Fault indication

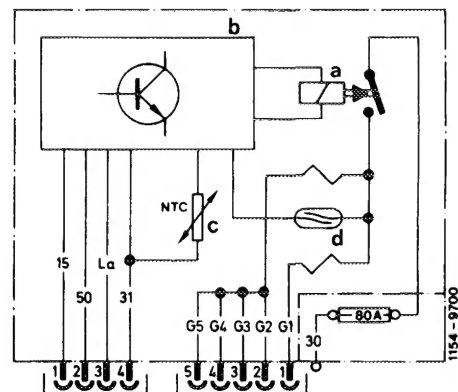
A fault in preglow system is indicated if the preglow indicator lamp is **not lighting up** when the key is actuated in position "2".

The following faults are indicated:

- Interruption of line to connection terminal 30.
- 80-amp fuse defective.
- Power relay in preglow time relay defective.
- Interruption of one or more lines to pencil element glow plugs.
- Interruption of one or more pencil element glow plugs.

**Note:** If tolerances of pencil element glow plugs or of Reed relay (d) are unfavorable, response of fault indicator only if two pencil element glow plugs are defective is acceptable.

Faults are indicated (pencil element glow plug resistance control) by comparing the current of pencil element glow plug G1 with current of remaining pencil element glow plugs G2–G5 (or G2–G4) connected in parallel.



The currents of the two lines to the pencil element glow plugs G1 and G2 up to G5 (or G2–G4) are rooted through two Reed relay coils with different numbers of windings connected opposite to each other.

If the current flow in both coils is the same, the magnetic fields will cancel each other and the Reed contact will not respond.

If the balance of the magnetic field is interrupted by the loss of one or several pencil element glow plugs, the Reed contact will close and the electronic system (b) will be activated.

The preglow indicator lamp switches off immediately and will therefore not light up when the preglowing begins.

